Biomass Power Research

Making electricity from trash and other biomass resources

Biomass is one of the oldest fuels known to human kind. Where in the past, biomass was used in fireplaces and campfires to provide heat, today, biomass resources such as trees, grasses and waste products are used in power plants to generate electricity. Biomass power is now the second largest renewable source of electricity, trailing only hydropower.

However, low fossil fuels costs have caused the growth of this clean, renewable power industry to stagnate. To reverse this trend and increase biomass power use, researchers at the National Renewable Energy Laboratory are developing advanced technologies that reduce the cost of biomass electricity by increasing the efficiency in which biomass is converted into electricity.

Biomass Power

In the United States, more than 350 biomass power plants generate over 7,500 megawatts of electricity—enough power to meet the energy needs of several million homes. These power plants use waste from paper mills, sawmills, wood products manufacturing, orchard prunings and agricultural byproducts. Scientists are also developing dedicated energy crops (fast growing trees and plants) grown specifically for use in biomass power plants.

NREL's Research Activities

The goal of NREL's biomass power research program is to increase the use and efficiency of biomass power. Research activities focus on increasing the variety of biomass resources power plants can use; developing advanced technologies and equipment to increase the amount of biomass converted to electricity; developing technologies to keep boilers clean and running efficiently; conducting feasibility studies for different feedstock materials; and monitoring demonstration projects.

Advanced Conversion Technologies

Today's power plants burn biomass to generate electricity in a process known as direct combustion. NREL helps industry improve direct combustion technologies, and is also developing advanced gasification and pyrolysis technologies that are more efficient than direct combustion and use a wider assortment of biomass feedstocks.

Direct combustion—Biomass contains alkali (contaminants) that can foul boilers, reduce efficiency and increase the cost of electricity. Because of this problem, only certain types of biomass materials can be used for direct combustion. NREL helps industry analyze the fouling problem, develop technologies

to reduce slag and ash formation that cause fouling, and increase the variety of biomass materials the boilers can process.

Gasification—NREL is developing a high-efficiency system that produces electricity through the integration of a gasifer and a fuel cell. The gasifer converts biomass into a gaseous fuel by using heat and a gasifying agent such as air or oxygen. The fuel cell directly converts the gaseous fuel into electricity through a chemical reaction.

Pyrolysis—NREL researchers are also developing pyrolysis technologies that use heat to chemically convert biomass into a pyrolysis oil containing fewer contaminants. The oil, which is easier to store and transport than solid biomass material, is then burned like petroleum to generate electricity.

Recent NREL Achievements

On-site Testing Equipment—NREL researchers developed and tested a transportable molecular beam mass spectrometer. This sophisticated measuring tool can be transported to biomass power plants around the country to help these facilities assess and control feedstock fouling and air emission problems.

Analyzing New Energy Crops—NREL managed 10 cost-shared feasibility studies conducted by industry partners. The studies analyzed using different energy crops (such as alfalfa, sugar cane, switchgrass, etc.) to make electricity and / or ethanol. Based on the results, the U.S. Department of Energy is now seeking industry partners interested in conducting demonstration projects with these energy crops.

Development of Low Alkali Oil—NREL researchers developed a method to take a high alkali biomass feedstock and convert it into a low alkali pyrolysis oil. The low alkali oil contains fewer contaminants and significantly increases conversion efficiency.

Benefits of Biomass Power

Biomass power helps improve the environment by reducing sulfur emissions (which help cause acid rain) and recycling carbon dioxide (biomass absorbs carbon dioxide during its growth period and releases it during the combustion phase). Biomass power also reduces the amount of waste sent to landfills; creates jobs and additional income for the agricultural industry; increases U.S. energy security; and provides new export markets.

Obstacles

Obstacles preventing wider-scale use of biomass power technologies include competition with low-cost natural gas, the need to develop dedicated energy crops and concern that lack of energy crop diversity could make soil less fertile. Improvements in existing biomass power technologies, development of advanced technologies and the development of a variety of dedicated energy crops grown on currently idle farmland will help overcome these obstacles.

Potential

In the U.S., biomass power annually generates over 7,500 megawatts of electricity and supports more than 66,000 jobs. The U.S. Department of Energy predicts that advanced technologies currently under development will help the biomass power industry install over 13,000 megawatts of biomass power by the year 2010, and create an additional 100,000 jobs.